

STARDUST GOES TO MARS: THE SCIM MARS SAMPLE RETURN MISSION. L. A. Leshin, Dept. of Geological Sciences and Center for Meteorite Studies, ASU, Tempe, AZ 85287-1404.

The technology developed for low-cost sample return by STARDUST and GENESIS, and the great advancement of laboratory capabilities to perform high precision analyses of very small samples, have resulted in an exciting concept for the first Mars sample return mission. This mission, called Sample Collection for Investigation of Mars (SCIM), is currently in Phase A competition for flight as the first Mars Scout mission.

When SCIM delivers the first martian samples to Earth it will dramatically expand scientific horizons by enabling distinctly new and diverse measurements and engaging a new community of scientists in the exploration of Mars. By returning more than a thousand 10 μm diameter dust particles and a liter of atmospheric gas, SCIM will provide fundamental advances in our understanding of Mars' habitability, geology, and climate. Existing high-precision, cutting-edge terrestrial laboratory instruments will produce high accuracy analyses of SCIM samples, addressing high-priority Mars science, including:

- The abundance of water in the martian near surface environment and the nature of its interaction with rocks; essential for assessing habitability
- The origin and composition of the major rock-types on Mars; key to unraveling martian geologic evolution
- The history of water and other gases in the martian atmosphere; critical for tracing martian climate through time.

Sample return is considered such an important component of the Mars Exploration Program (MEP) that it makes up one third of its implementation strategy of "seek-in situ-sample." SCIM offers a unique early opportunity for embarking on the first Mars sample return as the 2007 Scout mission. SCIM is responsive to 30 years of National Academy and other science community recommendations for sample return. SCIM will enable resolution of conflicting hypotheses generated by prior Mars missions. In addition, SCIM will enhance science return from future missions, pave the way for future sample returns, and allow NASA and the worldwide scientific community to enter the era of Mars returned sample analysis by 2011.

SCIM will be launched in August 2007. A "nodal reencounter" Earth-Mars- Mars-Earth trajectory provides ideal seasonal and latitude conditions for dust collection at the second Mars encounter. SCIM will arrive at Mars in April 2009 at $L_s = 245^\circ$, 14° S latitude, 70° longitude, at 5 am local time. During an aeropass with periapsis at 37.2 ± 2.5 km, SCIM's Dust

Collection Experiment (DuCE) will expose $>125\text{ cm}^2$ of aerogel to collect millions of particles, including >1800 particles with diameters over $10\text{ }\mu\text{m}$. The Atmosphere Collection Experiment (ACE) will collect at least 1 liter of atmosphere. The mission includes a Light-flash In-situ Dust Counter (LIDC) and a Camera Experiment (CamEx) to document dust and atmospheric conditions, respectively. The locations of these experiments within the flight system are designed to optimize their function and protect them (and the samples) from harsh aero-heating conditions.

Silica aerogel dust collectors are exposed near the aft end of the aeroshell where aeroheating effects are minimized. Analyses demonstrate that the largest, most scientifically valuable particles traverse the bowshock and reach the collectors having experienced only minor heating ($> 200^\circ\text{C}$ for <0.03 ms). Because the particles are small compared to the size of the bowshock, they will not break up while traversing this region. Extensive testing demonstrates that particles retain the vast majority of their chemical and mineralogical characteristics after hypervelocity capture in aerogel.

The DuCE consists of two sets of aerogel collector modules (CMs), 10 CMs per set, that are launched in position for sample collection. Ablative aeroshell coatings near the CMs ensure that no carbon-carbon ablation products from the aeroshell degrade sample collection. Following the aeropass, each CM set is reeled into the SRC for Earth return.

The ACE consists two, 1 liter collection tanks configured with tubing and valves to conduct atmospheric gases from an inlet at the stagnation point of the aeroshell, which provides high gas pressure with no potential contamination from the aeroshell material. The experiment includes a cryogenic collection system to increase the amount of collected gas.

The SCIM flight system is packaged within a carbon-carbon (C-C) aeroshell that protects from aeroheating and minimizes atmospheric drag losses, and therefore return ΔV . The aeroshell shape is flight heritage from the Radio Attenuation Measurement-C (RAM-C) program, is inherently aerodynamically stable, and requires no active control during the aeropass. The first-principles approach used for the SCIM flight system design focused on the physics of the actual sample collection and yielded a near optimal spacecraft physical configuration—while still allowing the maximum use of heritage subsystems from Stardust, Genesis, and Odyssey.